FLUID HEATING APPARATUS

CROSS REFERENCE TO RELATED APPLICATION

This application is based on Japanese Patent Application No. 2002-270092 filed on September 17, 2002, the disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to a fluid heating apparatus suitable for use in a vehicular air conditioner.

BACKGROUND OF THE INVENTION

With regard to a vehicular air-conditioning control device disclosed in JP-A-10-287123, a first thermistor for detecting temperature of a heat generating portion of an electric heater and a second thermistor for detecting temperature of water are disposed in a hot-water tank. When it is determined that the temperature difference between detected temperatures of the first thermistor and the second thermistor exceeds a predetermined level, it is judged that an abnormal condition is encountered. Thus, electric power supply to the electric heater is interrupted.

With regard to a cleaning device for bath hot water disclosed in JP-A-7-35407, hot water in a bath tub is forcedly circulated by a circulation pump and is filtered in a filter tank. Also, the heat of the water is maintained in a thermal insulating heater and activated in an activation tank. A first hot-water temperature sensor is disposed upstream of the thermal insulating heater and

a second hot-water temperature sensor is disposed downstream of the thermal insulating heater. When it is determined that the temperature difference between detected temperatures of the first and the second sensors exceeds a predetermined level, it is judged as a shortage of water. Thus, operation of the cleaning device is discontinued.

In a water heating device having a mechanical flow sensor, resistance is caused to a circulation of water. Further, it is required to tightly seal connecting portions of the flow sensor to prevent leaks of the water. Therefore, it is difficult to decrease manufacturing costs of the hot water generating device. Also in a water heating device having an electric flow sensor, it is difficult to decrease the manufacturing costs because an electric circuit is complicated.

Further, in a water heating device that detects an electric current supply to a water pump, a shunt resistor for detecting an electric current is required. This results in increases in size of an electronic control unit and the manufacturing costs. Further, in a water heating device that detects rotation speed of a water pump, a sensor for detecting the rotation speed is required. This results in increases in the water heating device and the manufacturing costs.

SUMMARY OF THE INVENTION

The present invention is made in view of the foregoing matter and it is an object of the present invention to provide a fluid heating apparatus capable of restricting boil-dry with a simple

means before it occurs.

According to the present invention, a fluid heating apparatus includes a pump for circulating fluid, a heating device for heating the fluid, a first temperature detecting means for detecting a temperature that changes in accordance with heat generation of the heating device, and a second temperature detecting means for detecting the temperature of the fluid. The second temperature detecting means is disposed downstream from the heating device. When it is determined that a temperature difference between detected temperatures detected by the first temperature detecting means and the second temperature detecting means exceeds a predetermined level, heating operation of the heating device is stopped.

In a case that operation of the pump is stopped for some reason or other and the circulation of the fluid is stopped, the temperature difference between the detected temperatures by the first temperature detecting means and the second temperature detecting means, which are separated from each other, increases greater than a temperature difference of a normal circulation where the fluid normally circulates. Based on this, the heating operation of the heating device is discontinued when it is determined that the temperature difference is greater than the predetermined level. Accordingly, it is possible to restrict boil-dry with a simple means.

The fluid heating apparatus is for example used for a heating apparatus for heating air blown into a compartment. The heating apparatus includes a heat exchanger that performs heat exchange between the fluid heated by the fluid heating apparatus and the air. The second temperature detecting means is disposed adjacent

to a fluid inlet of the heat exchanger through which the fluid flows into the heat exchanger.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of the present invention will become more apparent from the following detailed description made with reference to the accompanying drawings, in which like parts are designated by like reference numbers and in which:

Fig. 1 is a schematic diagram of an air conditioner according to the first embodiment of the present invention;

Fig. 2 is a flow chart of control of the air conditioning apparatus according to the first embodiment of the present invention; and

Fig. 3 is a schematic diagram of an air conditioner according to the second embodiment of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

Embodiments of the present invention will be described hereinafter with reference to the drawings.

[First embodiment]

In the first embodiment, a fluid heating apparatus 2 is used for a vehicular air conditioner, as shown in Fig. 1. A heater 1 is a heat exchanger for performing heat exchange between fluid (e.g. water) heated in the fluid heating apparatus 2 and air to be blown into a passenger compartment of a vehicle. The fluid heating apparatus 2 will be described later in detail.

An air conditioning case 3 is a duct forming an air passage

through which the air to be blown into the passenger compartment flows. The heater (hereinafter, heat exchanger) 1 is disposed in the air conditioning case 3. An evaporator 4 is disposed air-upstream of the heat exchanger 1 in the air conditioning case 3. The evaporator 4 constructs an air cooling means for cooling the air.

The evaporator 4 is included in a vapor compression refrigerant cycle system, which transfers heat of a low-temperature refrigerant to a high-temperature refrigerant, as a low-pressure side heat exchanger. The vapor compression refrigerant cycle system also includes a compressor 5, a radiator 6 for cooling high-pressure and high-temperature refrigerant, which is discharged from the compressor 5, a pressure reducing device 7 for decompressing and expanding the high pressure refrigerant, which is cooled in the radiator 6. In the embodiment, the compressor 5 is driven by an electric motor.

A blower 19 is disposed air-upstream of the evaporator 4. An inside and outside air switching unit 8 is provided on a side of an air inlet of the blower 19. The inside and outside air switching unit 8 controls volumes of inside air inside of the passenger compartment and outside air outside of the passenger compartment and introduces the air into the blower 19.

In the air conditioning case 3, an air mixing door 9 is disposed air upstream of the heat exchanger 1. The air mixing door 9 controls volumes of air to be heated by the heat exchanger 1 and the cooled air bypassing the heat exchanger 1, thereby constructing a temperature adjusting means for adjusting temperature of the air to be blown into the passenger compartment.

Next, the fluid heating apparatus 2 will be described.

A pipe 10 through which the fluid flows includes a curved portion. The curved portion for example has substantially a U-shape, as shown in Fig. 1. The pipe 10 is disposed such that the open portion of the U-shape faces down and the turn portion of the U-shape is located higher than the open portion, as denoted by a up and down arrow in Fig. 1. The electric heater 11 such as a sheathed heater is disposed to be in contact with an outside wall of the U-shaped portion of the pipe 10, so that the electric heater 11 heats the U-shaped portion. The electric heater 11 and the pipe 10 are integrated and embedded in a metal member such as aluminum having high heat conductivity.

A protect casing 12 is a cover encasing the electric heater 11 for protecting the electric heater 11 and the heated portion of the pipe 10. A heat insulator such as resin or glass wool is provided on an inside wall of the protect casing 12.

A heat protect temperature sensor (first sensor) 13 is disposed proximate to a downstream portion 10a of the heated portion of the pipe 10. The first sensor 13 detects the temperature of a wall of the pipe 10 proximate to the downstream portion 10a. Thus, the first sensor 13 indirectly detects the temperature of the heated fluid at a position proximate to the downstream portion 10a of the heated portion. That is, the first sensor 13 detects the temperature that increases or changes in accordance with heat generation of the electric heater 11. Here, the first sensor 13 constructs a first temperature detecting means.

A heated fluid sensor (second sensor) 14 detects the

temperature of the wall of the pipe 10 at a fluid inlet 1a of the heat exchanger 1, thereby indirectly detecting temperature of the heated fluid. The second sensor 14 is disposed downstream from the first sensor 13 so that the second sensor 14 detects temperature of the heated fluid downstream from the first sensor 13. The second sensor 14 constructs a second temperature detecting means.

An electric pump 15 and a reserve tank 16 are disposed in the fluid passage. The electric pump 15 circulates the fluid and the reserve tank 16 absorbs change in a volume of the fluid circulating in the fluid heating apparatus 2. Electric devices such as the electric heater 11 and the pump 15 are controlled by an ECU (electronic control unit) 17.

Next, a characteristic operation of the embodiment will be described with reference to a flow chart shown in Fig. 2.

First, when the air conditioning unit is turned on, it is determined whether an operation signal is sent to the pump 15 from the ECU 17 at S100. If it is determined that the operation signal is sent to the pump 15, it is determined whether a temperature difference ΔT between a detected temperature T1 of the first sensor 13 and a detected temperature T2 of the second sensor 14 exceeds a predetermined level Tp at S110.

If it is determined that the temperature difference ΔT is greater than the predetermined level Tp, electric power supply to the electric heater 11 is interrupted so that a heating operation of the electric heater 11 is stopped at S120. If it is determined that the temperature difference ΔT is equal to or less than the predetermined level Tp, the rate of the electric power supply to

the electric heater 11 is controlled so that the detected temperature T2 of the heated fluid sensor 14 reaches a target level at S130. This step constructs a fluid heating rate control means. Specifically, the target level is set as a target temperature of the heated fluid flowing into the heat exchanger 1. The target level is previously calculated by a target temperature calculating means.

Next, advantageous effects of the embodiment will be described.

In a case that the operation of the pump 15 is stopped for some reason or other, the circulation of the heated fluid is stopped. Since the heated fluid is not supplied to the heat exchanger 1, the temperature difference ΔT becomes greater than that of a normal operation where the heated fluid normally circulates.

Based on this fact, the electric power supply to the electric heater 11 is stopped when the temperature difference ΔT is greater than the predetermined level Tp. Therefore, it is possible to restrict boil-dry with a simple means before it occurs.

When the circulation of the heated fluid is stopped, the detected temperature T1 of the first sensor 13 is higher than that of the normal circulation. Therefore, it is considered to stop the electric power supply to the electric heater 11 when the detected temperature T1 exceeds a predetermined temperature by assuming that the operation of the pump 15 is stopped.

Specifically, the target temperature of the second sensor 14 is 80 degrees Celsius and the detected temperature T1 of the first sensor 13 is 82 degrees Celsius while the heated fluid circulates normally, for example. When the detected temperature T1 of the first sensor 13 exceeds the predetermined temperature (e.g. 110 degrees

Celsius), the electric power supply to the electric heater 11 is stopped. In this case, the electric power supply to the electric heater 11 continues so that the detected temperature T1 (82 degrees Celsius) increases by 28 degrees, that is, the electric power supply to the electric heater 11 is maintained until the detected temperature T1 reaches the predetermined temperature (110 degrees Celsius).

In the embodiment, the heated fluid is cooled in the heat exchanger 11. That is, when the heated-fluid supply from the electric heater 11 is stopped, the detected temperature T2 of the second sensor 14 decreases, while the detected temperature T1 of the first sensor 13 increases. Therefore, the increase of the temperature difference ΔT is greater than the increase of the detected temperature T1 of the first sensor 13.

Accordingly, since the boil-dry is judged based on the temperature difference ΔT in the embodiment, the boil-dry is detected at a stage earlier than the case of judging it based on only the detected temperature T1 of the first sensor 13.

In the embodiment, the boiling point of the fluid is 110 degrees Celsius. The temperature difference ΔT is 3 degrees while the fluid normally circulates. In addition, the predetermined level Tp of the temperature difference ΔT is 10 degrees in consideration of detecting accuracy.

[Second embodiment]

As shown in Fig. 3, in the second embodiment, the first sensor 13 is arranged at a position proximate to a turn portion 10b of the curved portion of the pipe 10, which is heated by the electric heater 11. Here, the position proximate to the turn portion 10b

includes the turn portion 10b itself, which is denoted by a chain double-dashed circle L in Fig. 3.

The first sensor 13 is attached on the surface of the metal member, which integrates the electric heater 11 and the pipe 10, at the position proximate to the turn portion 10b and indirectly detects the temperature of the heated fluid. Since the heat conductivity of the aluminum is higher than that of stainless forming the pipe 10, the detected temperature T1 of the first sensor 13 of the second embodiment is higher than that of the detected temperature T1 of the first embodiment with respect to the same heated fluid temperature.

Next, effects of the embodiment will be described.

When the circulation of the heated fluid is stopped, the fluid boils locally and causes bubbles. Because the bubbles collect at the upper portion, which is an apex or a proximity to the apex, of the heated portion of the pipe 10, the temperature of the upper portion of the pipe 10 increases in accordance with an increase in pressure. Based on this, because the first sensor 13 is arranged proximate to an upper half of the electric heater 11, the temperature change is accurately detected. Accordingly, it is possible to detect the boil-dry at an early stage.

In general, a straight electric heater generates heat most in substantially a middle portion in its longitudinal direction. In the embodiment, since the first sensor 13 is arranged proximate to the turn portion 10b of the heated portion, the location of the first sensor 13 generally corresponds to a portion where heat generation is highest within the electric heater 11. Accordingly,

since the change in the temperature is accurately determined, the boil-dry can be detected early.

[Other embodiments]

In the above embodiments, the fluid heating apparatus 2 is used for the air conditioner. However, the present invention is not limited to the above. The present invention can be used for a hot water supplying device, for example.

Further, the electric heater 11 is not limited to the sheathed heater. Another heating device such as a gas heater can be used in place of the electric heater 11.

The shape of the heated portion of the pipe 10 is not limited to substantially U-shape. Alternatively, the heated portion of the pipe 10 can have for example a W-shape or a straight shape.

The arranging position of the first sensor 13 is not limited to the positions of the above-described embodiments.

The present invention should not be limited to the disclosed embodiments, but may be implemented in other ways without departing from the spirit of the invention.